



*DOER Green Communities
Webinar*

September 11, 2013

COMMONWEALTH OF MASSACHUSETTS

*Deval L. Patrick, Governor
Richard K. Sullivan, Jr., Secretary
Mark Sylvia, Commissioner*

LED Streetlights

What Is Your Plan?

Aimee Powelka

*Municipal Efficiency Coordinator
Green Communities Division, DOER*

Edward Bartholomew

*Commercial Lighting Program Manager
National Grid*

Green Communities Division

Serves as the hub for all Massachusetts cities and towns on energy matters



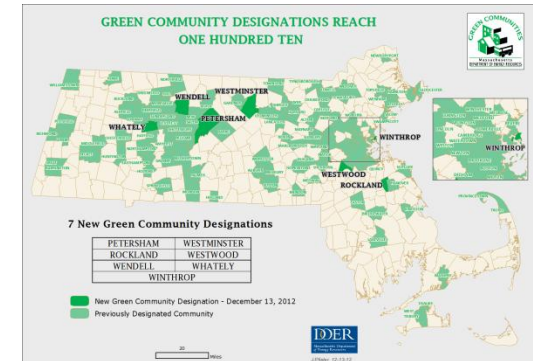
Helping Massachusetts Municipalities Create A Cleaner Energy Future



Green Communities Division

Programs & Resources for Municipalities

- Green Communities Designation and Grant Program
- **MassEnergyInsight** energy tracking tool
● ● ● ● ● POWERING EFFICIENCY
- Municipal Energy Efficiency Program
- Renewable Energy and Alternative Transportation
- Performance Contracting Technical Assistance (EMS)
- Website filled with tools & resources - www.mass.gov/doer
- Email updates via listserv – Sign up by sending an email to: join-ene-greencommunities@listserv.state.ma.us



Helping Massachusetts Municipalities Create A Cleaner Energy Future



Outreach - Regional Coordinators

- Regional Coordinators act as direct liaisons with cities and towns on energy efficiency and renewable energy activities
- Located at each of the DEP Regional Offices:



SERO – LAKEVILLE: Seth Pickering
Seth.Pickering@state.ma.us

NERO – WILMINGTON: Joanne Bissetta
Joanne.Bissetta@state.ma.us



CERO – WORCESTER: Kelly Brown
Kelly.Brown@state.ma.us

WERO – SPRINGFIELD: Jim Barry
Jim.Barry@state.ma.us



Recording & Presentation

- The webinar is being recorded and will be available on our website in approximately 48 hours at:
www.mass.gov/energy/greencommunities
- The slide presentation will also be posted at:
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- Website and contact information is listed at end of presentation





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LED Streetlights

Background

Aimee Powelka
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Green Communities Division, DOER*

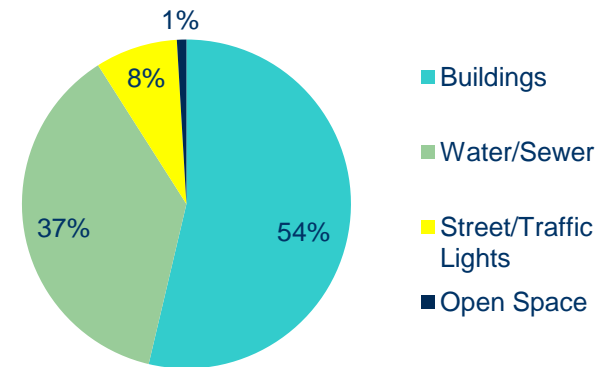
Streetlights

- Purpose

- Accident prevention
 - Reduce pedestrian crashes and fatalities
 - Illuminate intersections and/or hazards
- Decorative
- Deter crime

- Consequences

- Light pollution
- Cost for energy and maintenance
- Use energy – emit pollutants
- Loss of night vision



**Electricity Use by MEI
Municipalities, FY2013**

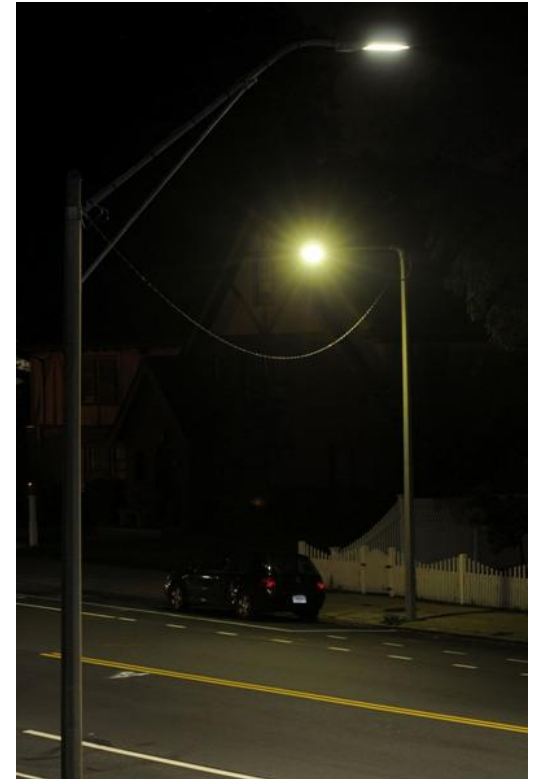


Helping Massachusetts Municipalities Create A Cleaner Energy Future



Advantages of LED Streetlights

- Improved safety through enhanced visibility
- Decreased energy consumption
- Visible commitment to efficiency
- Reduced maintenance costs due to longer life
- Decreased light trespass and pollution
- Instant-on
- An opportunity for programmable controls



Poll Question #1

- Does your community have any LED streetlights?
 - Yes, in many places
 - Yes, a few or a pilot
 - Working on a large-scale retrofit
 - No
 - Unsure



Understanding- LED Street Lighting



BetaLED
Sentry Equipment—Oconomowoc, Wisconsin

Presenter-

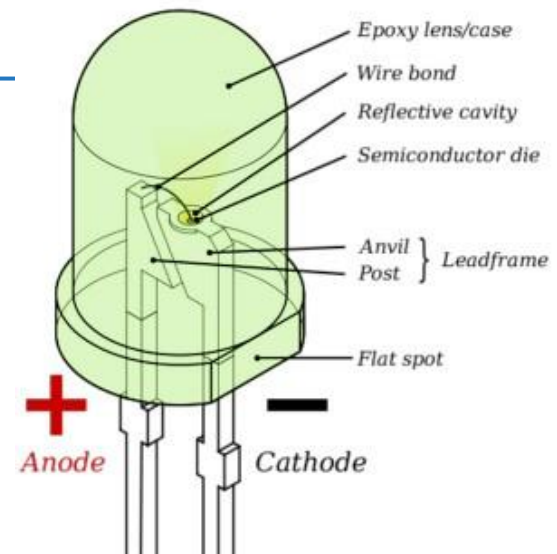
Edward Bartholomew, LC, IES, LEED AP

Commercial Lighting | Program Manager

Solid State Lighting –LED's

Light-Emitting Diodes (LEDs) are solid-state electronic devices that generate light via the transformation of electric energy to radiant energy within the crystalline structure of a semiconductor chip.

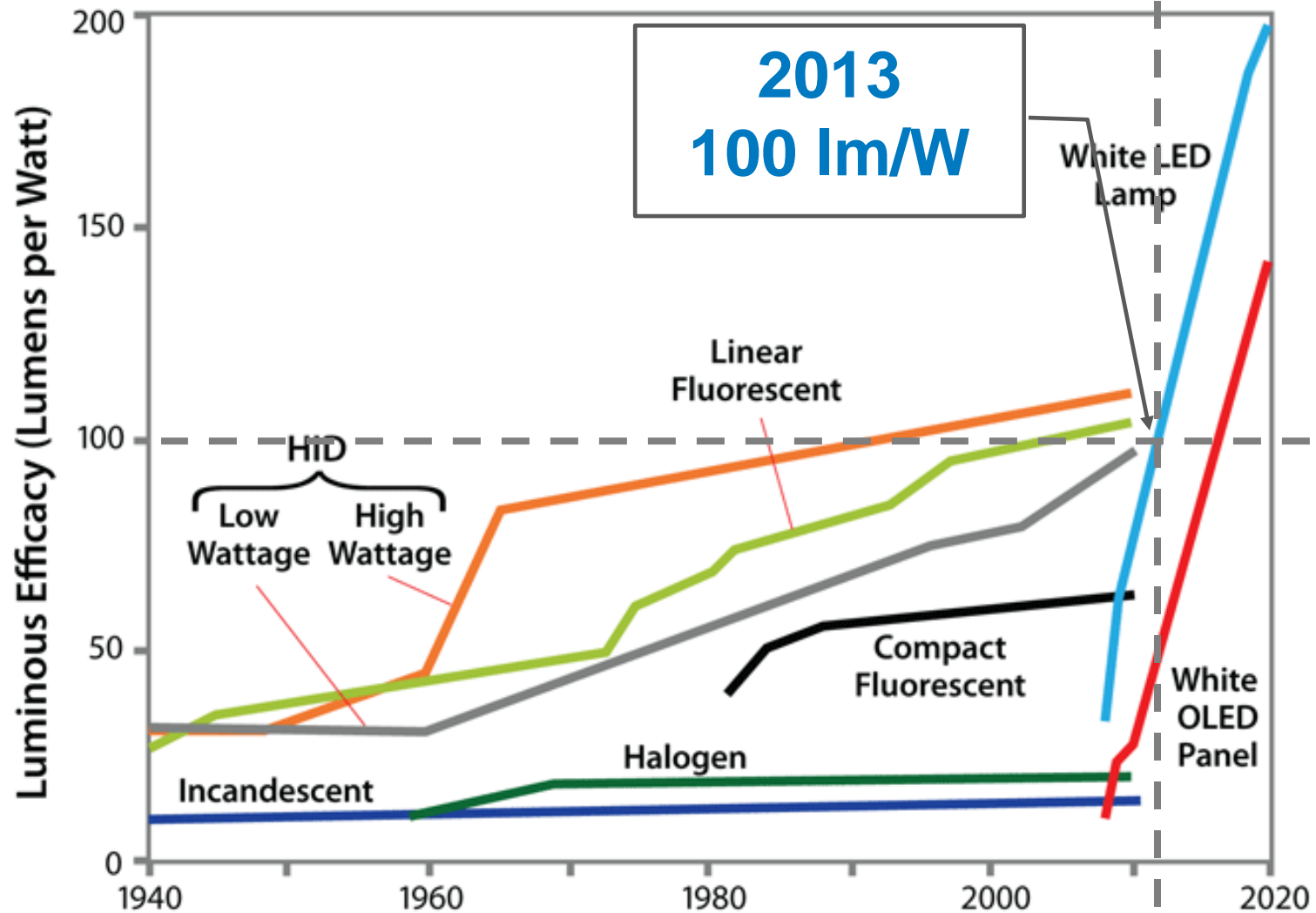
- No heated filaments or gases
- Can be reliable, durable, efficacious, long-life, flexible, and very efficient with improved heat sinking and proper care
- Optically effective for direct illumination without much light loss.
- White LED's have a chromaticity closest to natural daylight
- Performance of LED's decreases with increasing temperature



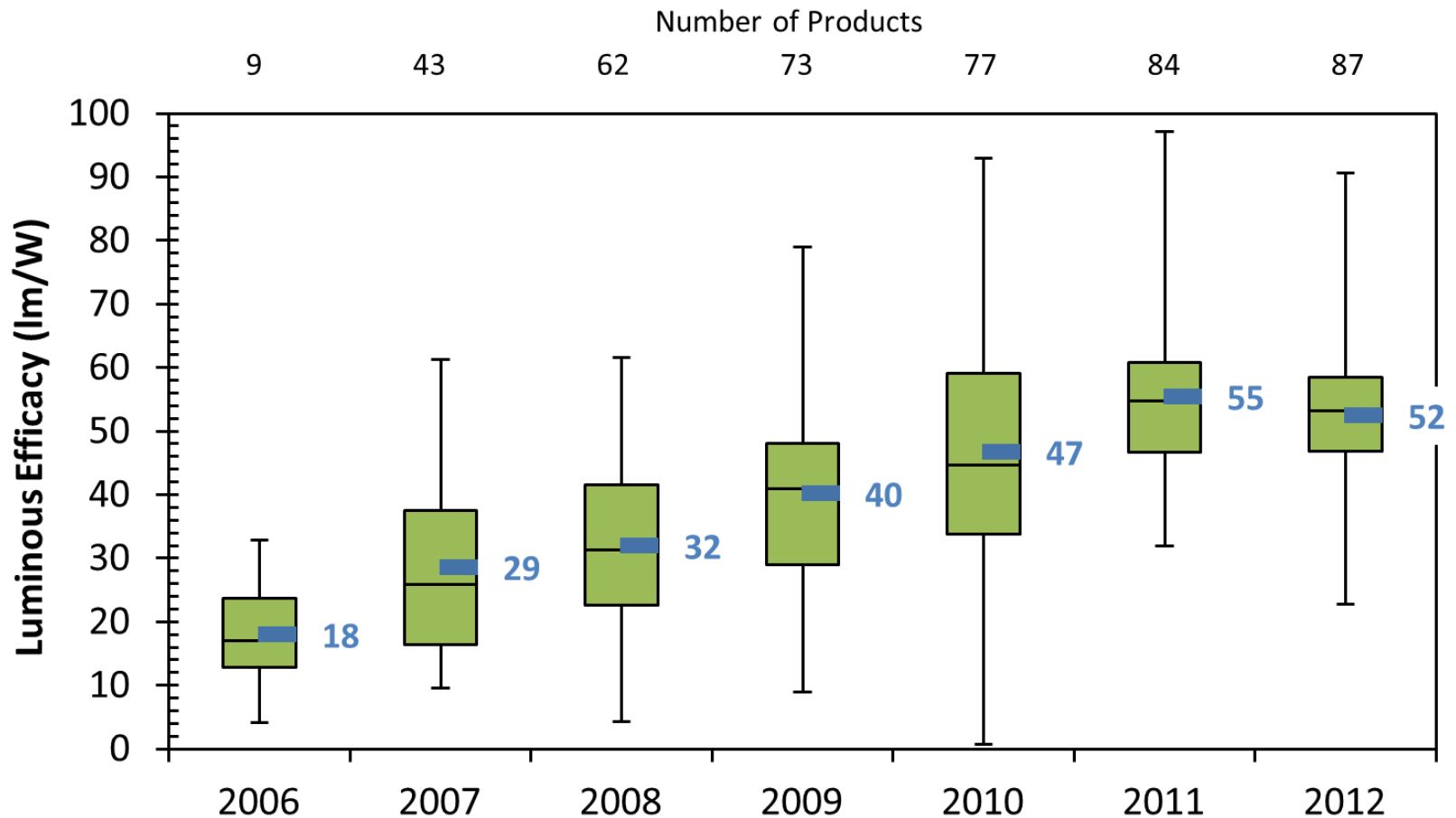
Characteristics Effecting LED Performance

	Light Output	Junction Temp T _j	Efficacy	Lifetime	Cost (\$/lumen)	CCT
Increase LED Input Current	Higher ↑	Hotter ↑	Worse ↓	Shorter ↓	Lower ↓	Larger shift (Typically cooler)
Decrease LED Input Current	Lower ↓	Cooler ↓	Better ↑	Longer ↑	Higher ↑	Smaller shift
Improve Heat Sinking	Higher ↑	Cooler ↓	Better ↑	Longer ↑	Depends on design	Smaller shift

Advancement of LED's



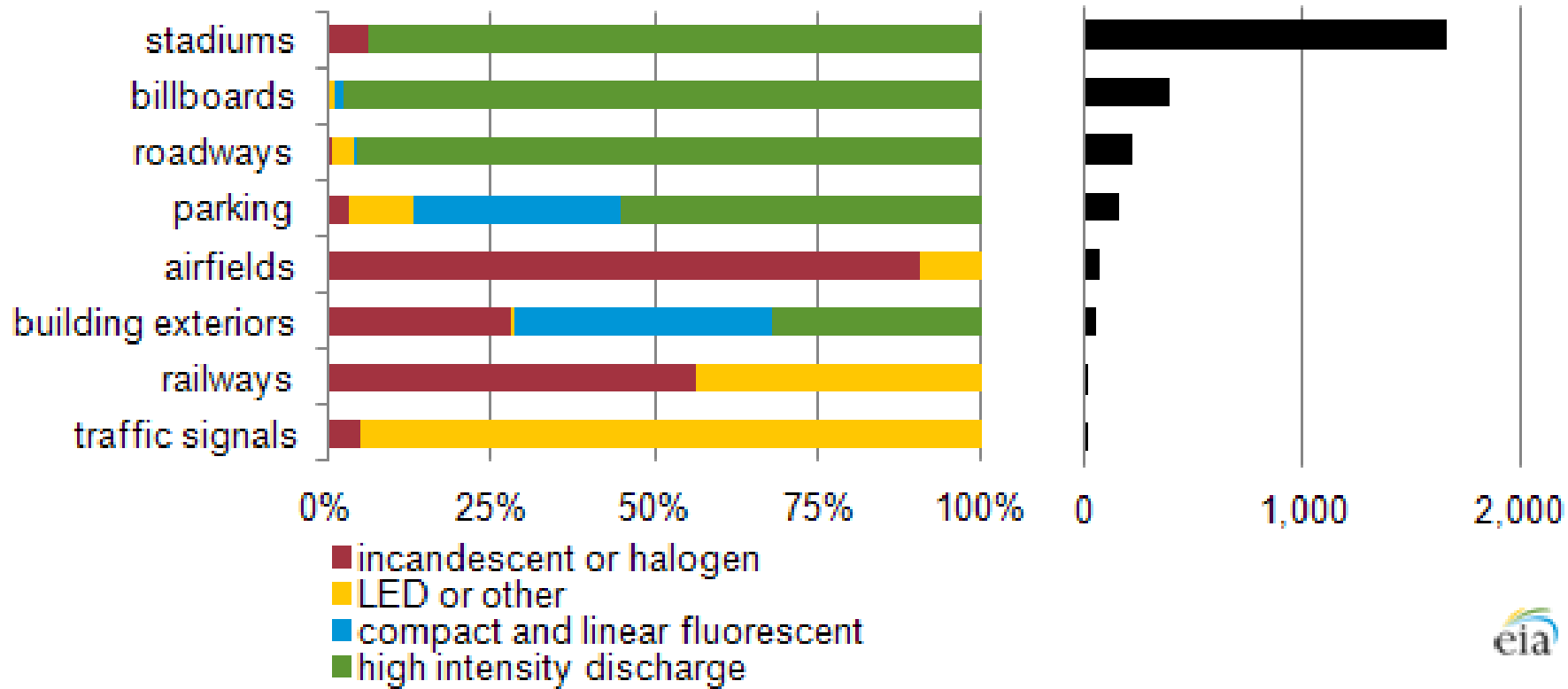
Today's LED Efficacy Trends



LED Quality Characteristics

Estimated inventory of outdoor lamps
technology type by subsector

average wattage per lamp
(watts)



Lamp Comparison

	HPS	MH	LED
Luminaire (system) watts	183W	208W	153W
CCT	2000 K	4000 K	6000 K
CRI	22	65	75
Rated lamps lumens, initial	16000	11700	n/a
Downward luminaire efficiency	70%	81%	n/a
Downward luminaire lumens, initial	11,200	9,477	10,200
Luminaire efficacy	61 lm/W	46 lm/W	67 lm/W

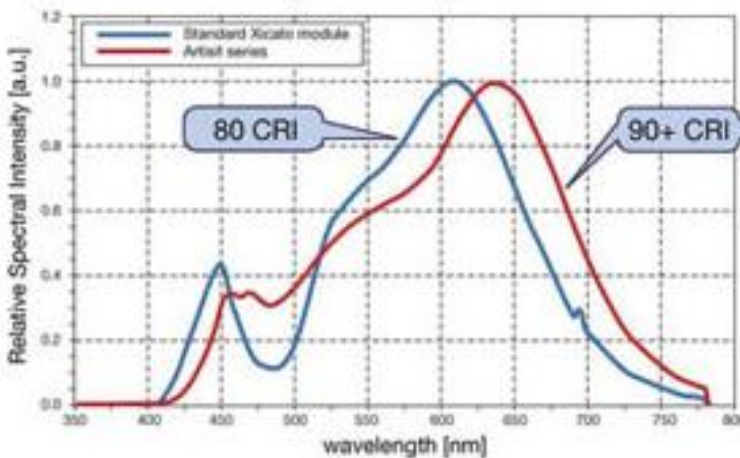
Sources: HPS and MH: published luminaire photometric (.ies) files. LED: manufacturer data. 2008

Lamp Comparison

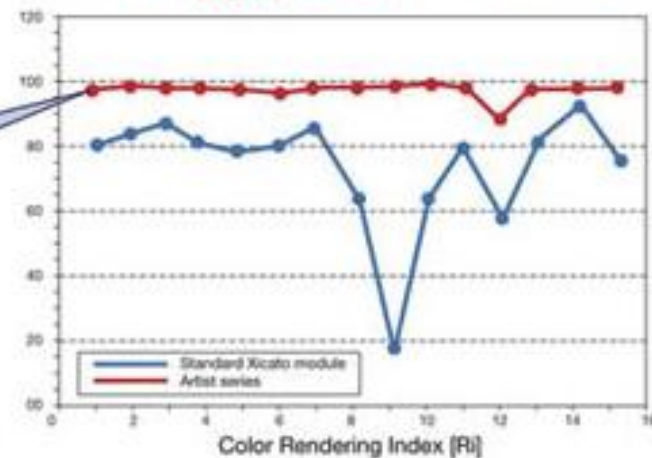
	Existing 70W HPS	LED 3-array	Optional LED2-array
Total power draw	97W	72W	48W
Average illuminance	3.54 fc	3.63 fc	2.42 fc
Maximum illuminance	7.55 fc	5.09 fc	3.40 fc
Minimum illuminance*	1.25 fc	1.90 fc	1.27 fc**
Max/Min Ratio (uniformity)	6.04:1	2.68:1	2.68:1
Energy consumption per luminaire***	425 kWh/yr	311 kWh/yr	210 kWh/yr
Energy savings per luminaire	--	114 kWh/yr (26.8%)	215 kWh/yr (50.6%)

LED's & Color Rendering Index -CRI

Spectra Artist (T=70°C)



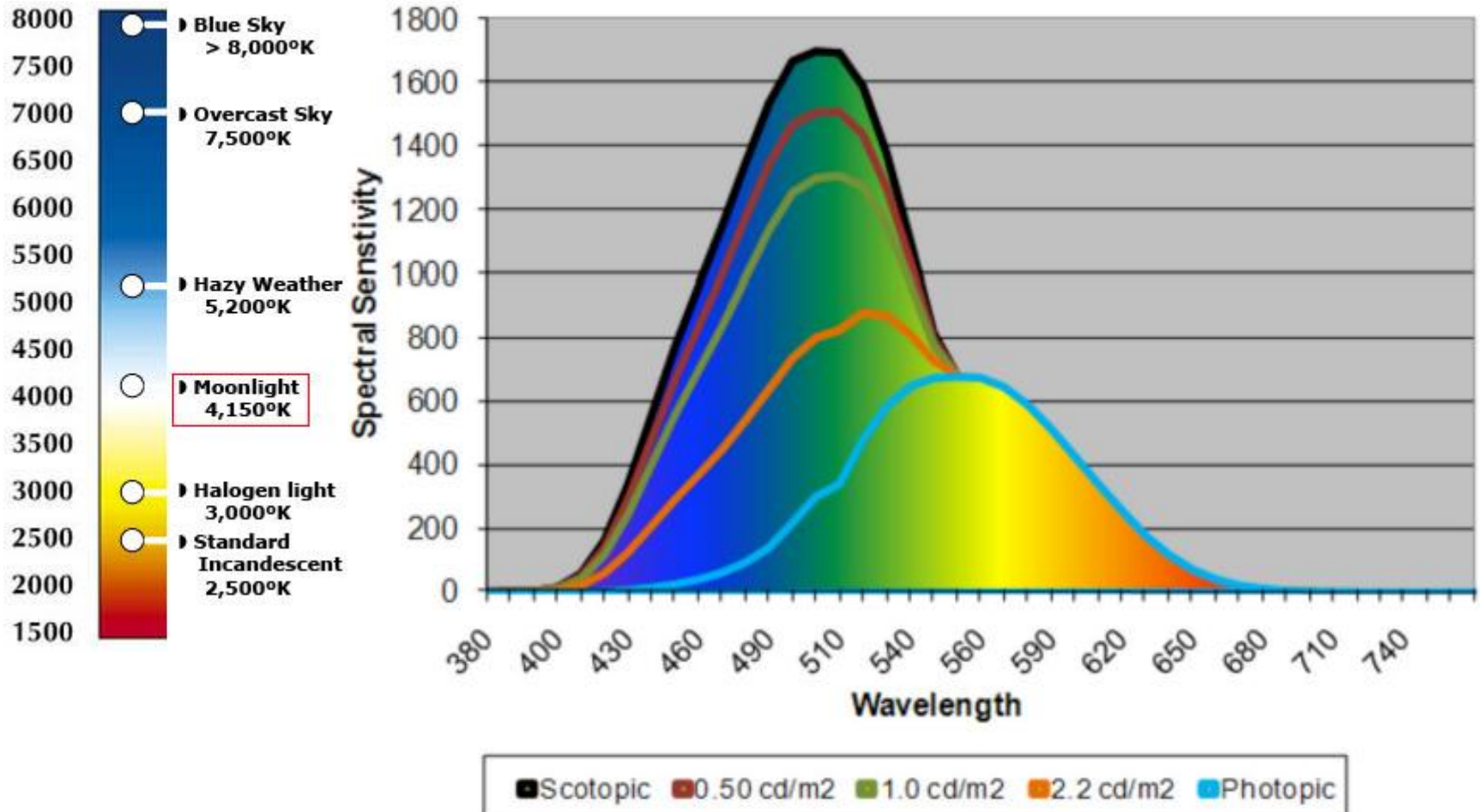
CRI = 97 (typ) (95 Min)



	Ra	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
Standard	81	80	85	89	81	78	80	86	66	16	64	79	58	81	93	75
Artist	98	98	99	98	98	98	97	98	98	98	99	98	88	98	98	98



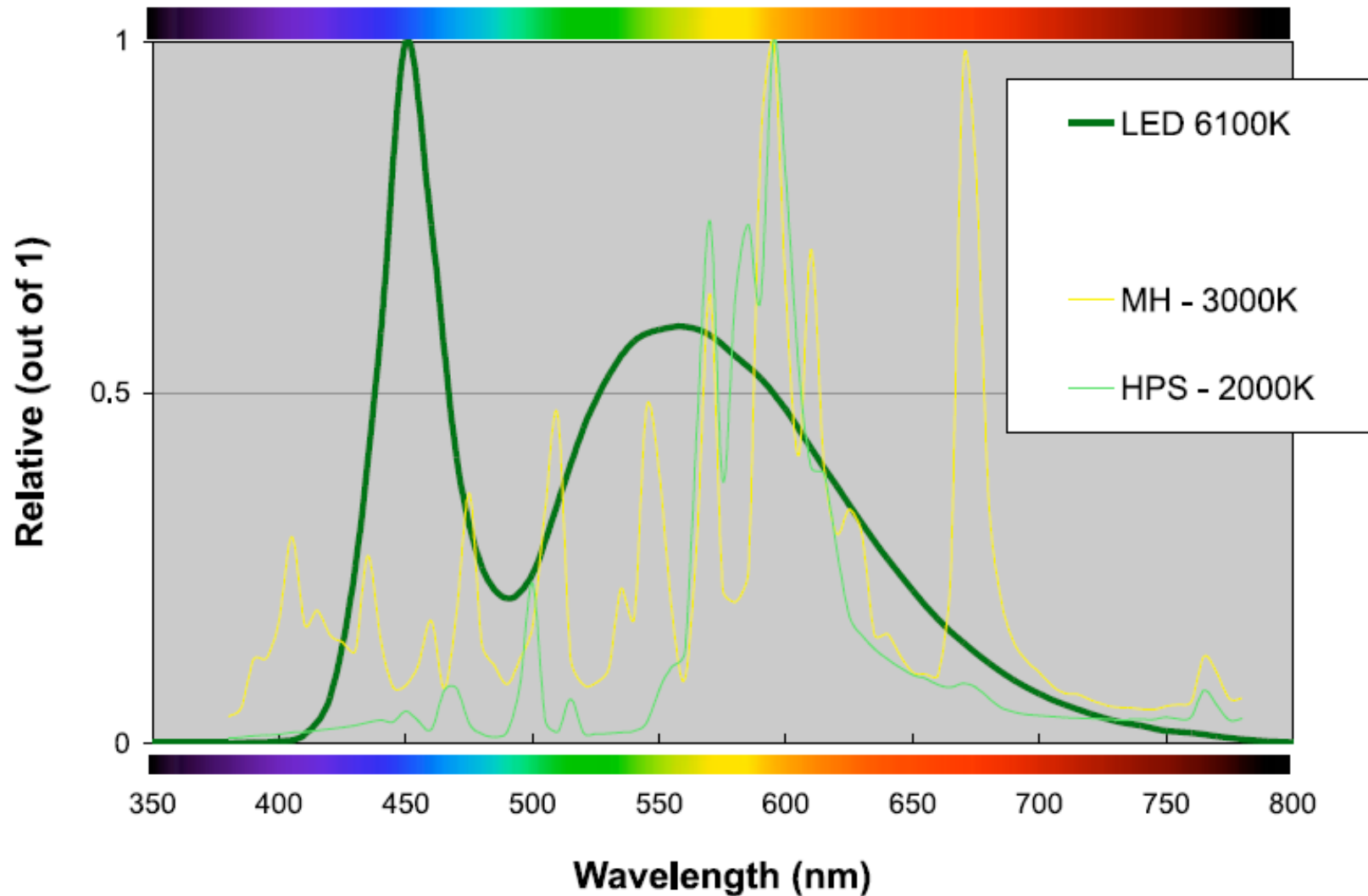
Broad-Spectrum (White LED) Outdoor Lighting



Broad-Spectrum (White LED) Outdoor Lighting

- White LEDs with Broad-spectrums including short-wavelength “blue” light are more efficacious than limited spectrum light (i.e. HPS) it is possible to reduce photopic light levels (and wattages).
- Broad-spectrum light sources contribute to better visual performance:
 - Improves small target detection and detection distance
 - provides improved color contrast for visual recognition
 - accommodates the adaptive shift from photopic (cone) vision toward scotopic (rod) vision.
 - Increases peripheral rod based, non-fovea object and motion detection

Spectral Power Distribution -SPD



LM-79

LM-79 is an approved method for taking electrical and photometric measurements of SSL products.

- Total flux (light output)
- Electrical power
- Efficacy
- Chromaticity
- Intensity distribution



Sample Tested: L4-18W-41K-132

(TÜV SÜD# 208-3)

Manufacturer: RedBird LED



Sample Description: LED Replacement Tube 4ft

Test Orientation: Intended (Horizontal)

Date of Test: May 24th 2012

Tested by

Reviewed by

Tim Gentry

Bryan Cubitt

Tim Gentry

Bryan Cubitt

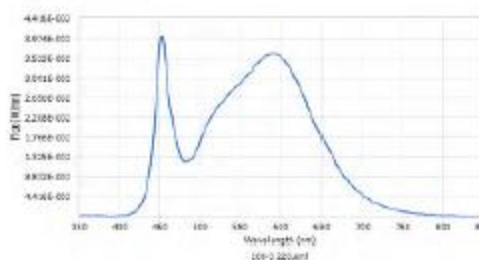
TÜV SÜD Project Handler

TÜV SÜD Program Manager



Test Results:

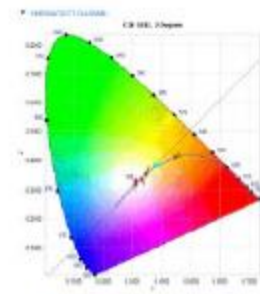
SPECTRAL FLUX GRAPH



Spectral Response

Photometric Test Results

Luminous Flux (Lumens)	2,104
Efficacy (Lumens/Watt)	110.2
Color Temperature (CCT K)	4055
Color Rendering Index (CRI)	81.9
R _a Value	3.4
Radiant Flux (W/nm)	6.36
Chroma u' / Chroma v'	0.2229 / 0.5031
Duv	0.00210



Chromaticity Diagram

Tristimulus Values: x / y = 0.3794 / 0.3806

Electrical Test Results

Input Power (Watts)	19.09
Input Voltage (Volts)	220.03
Input Current (Amps)	0.0921
Power Factor	0.963
A-THD / V-THD	14.47% / 0.13%
Input Frequency (Hz)	60.0
Stabilization Time	40 minutes
Ambient Temperature	25.3°C

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This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

TÜV SÜD America, Inc.
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Alpharetta, GA 30005 USA

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Page 1

Confidential Report



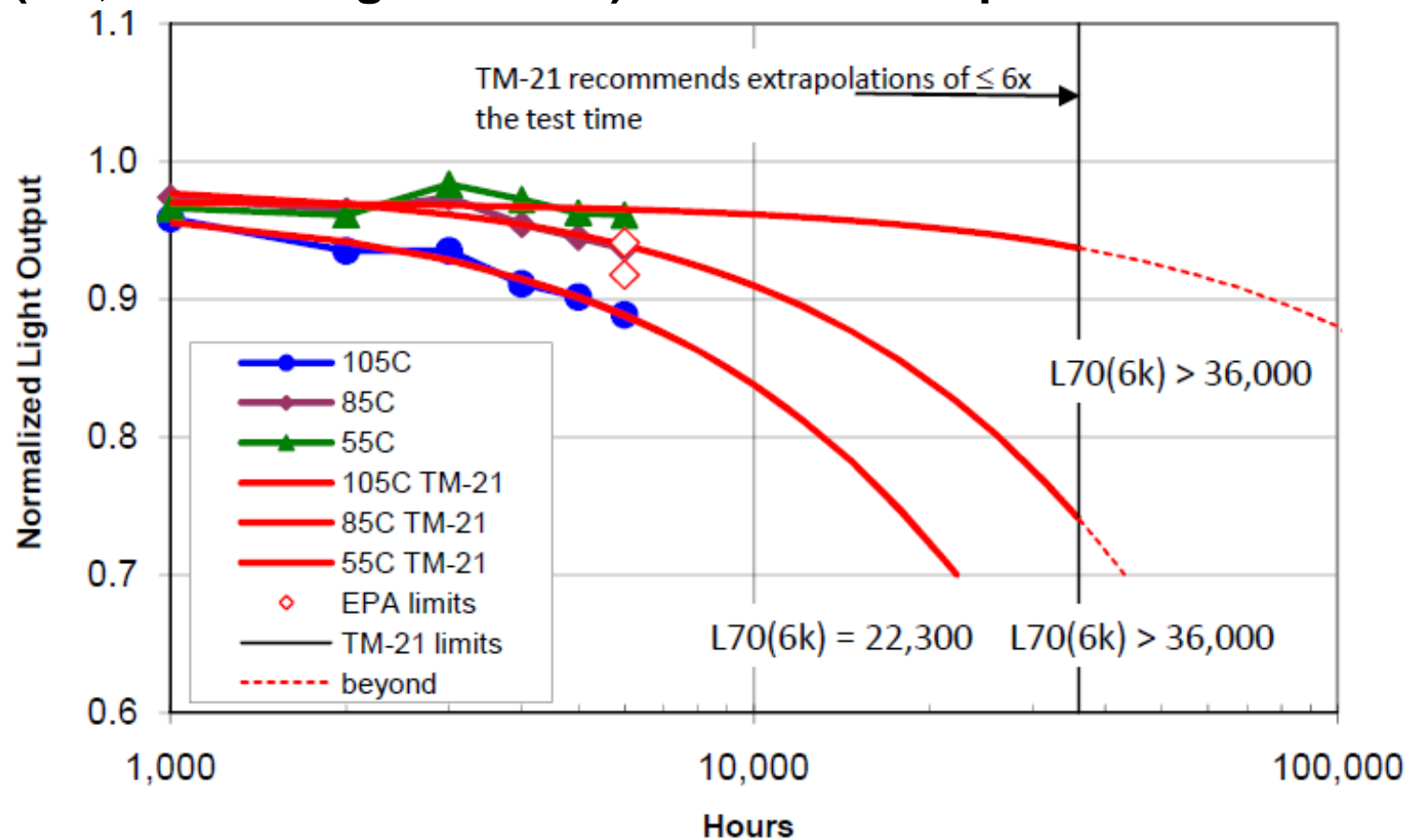
Lab Code: 500065-0

TÜV SÜD America is
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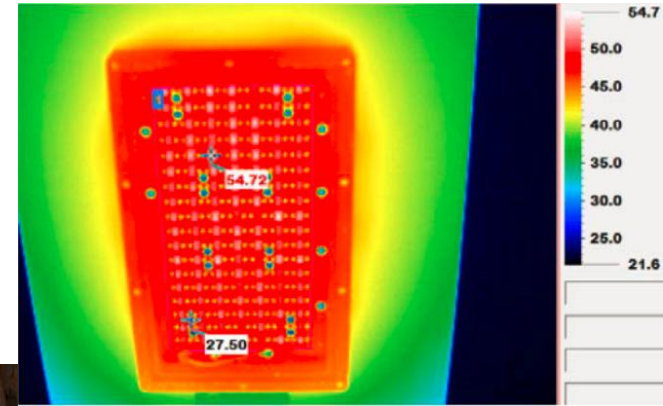
LM-80

LM-80 is an approved method for measuring the lumen maintenance (L70), of LED packages arrays, and modules, lamps (i.e., the LED light source) at various temperatures.



In-situ Testing

In-situ testing exceeds LM-79 to provide a more accurate estimate of actual operating temperature in installed conditions. Especially as this relates to thermal performance.



Street Lighting and Adaptive Controls

Goal: **Increase Energy Savings**

Strategy: **“Smart” Control System Remote/Programmable Dimming**

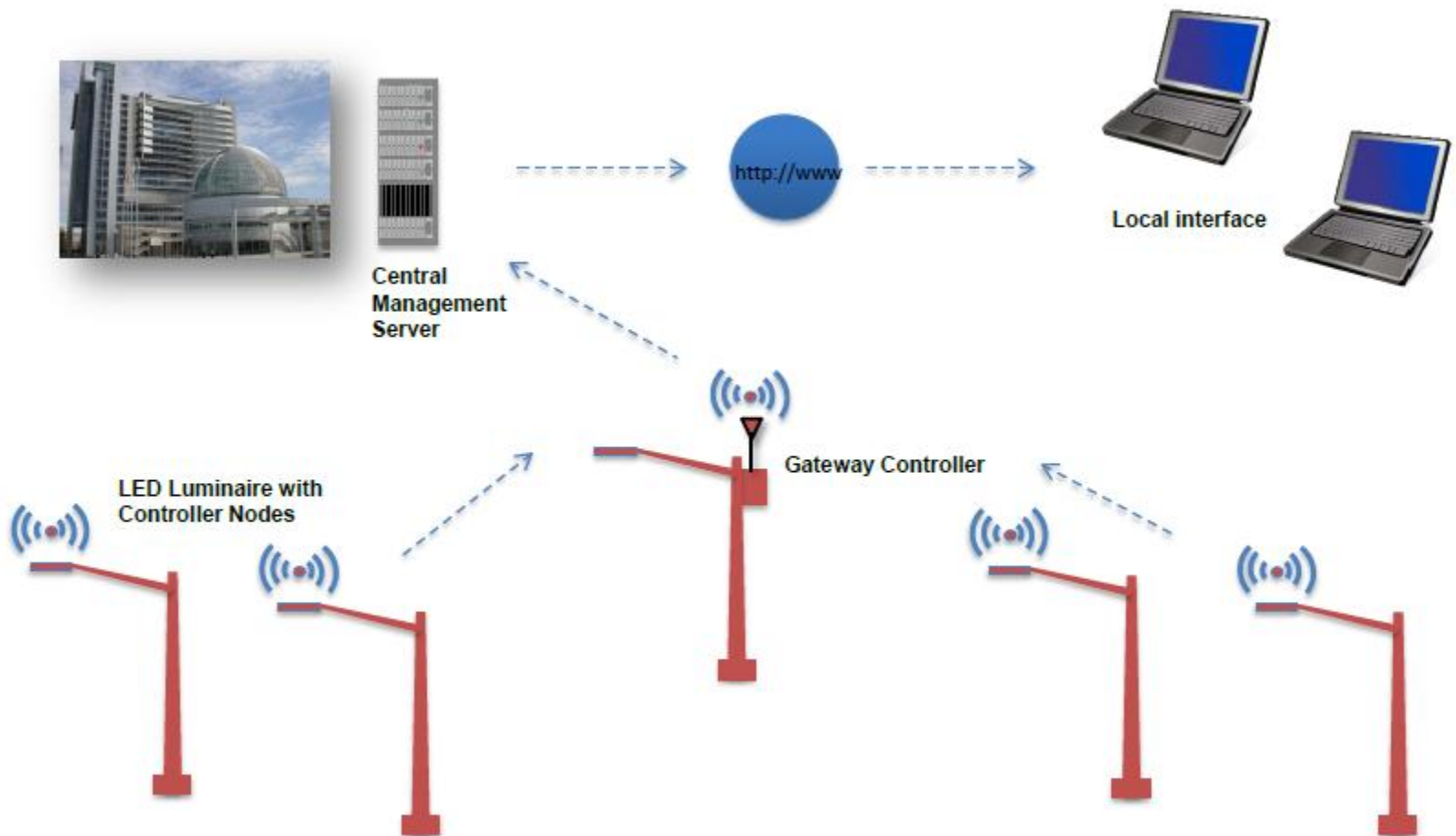
- Lighting based on activity level
- Reduce energy use
- Minimize light pollution
- Consumption Data thru Metering
- Pay for actual energy consumed



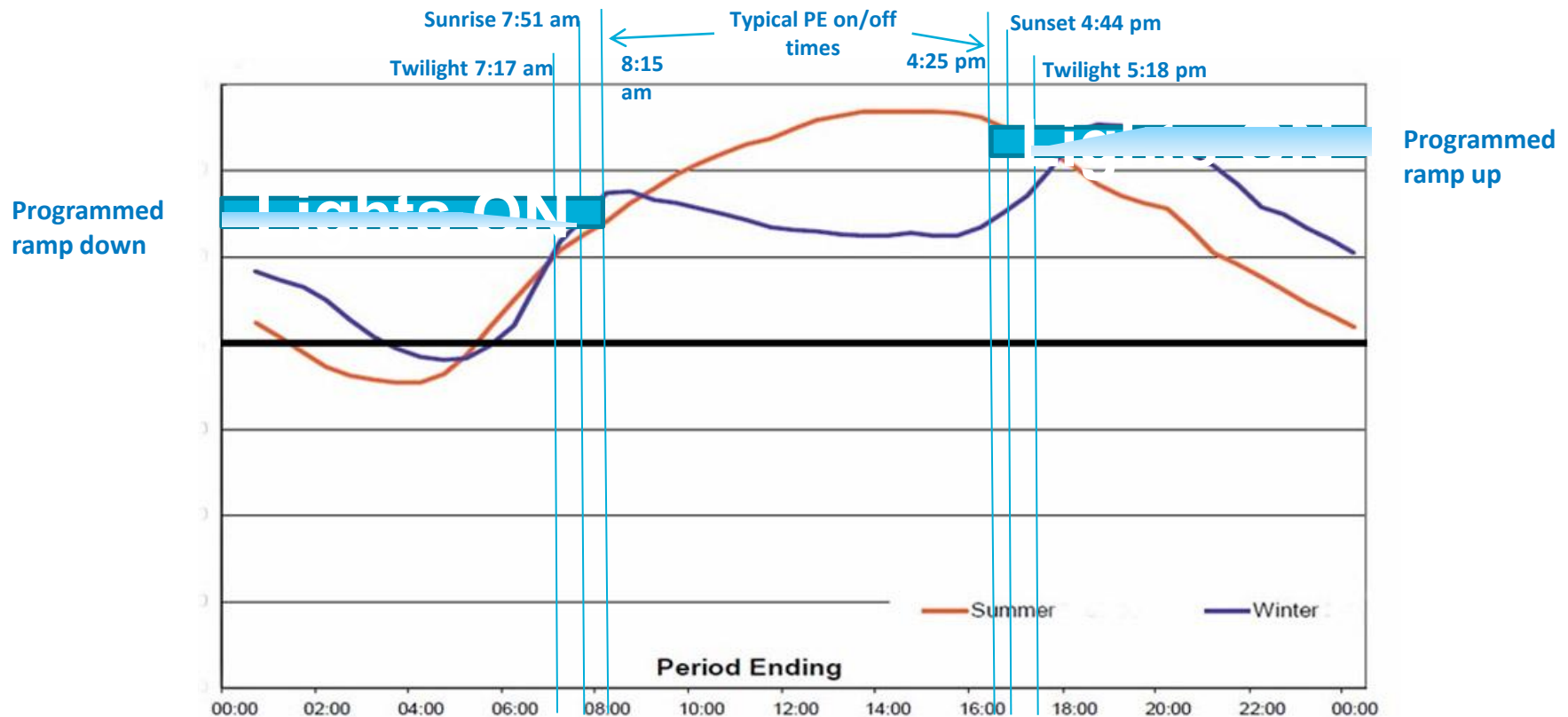
Key findings from the [report](#) (PDF), *Lighting the Clean Revolution: The Rise of LED Street Lighting and What it Means for Cities*, include:

“ - LEDs achieve the expected 50 to 70% energy savings, and reach up to 80% savings when coupled with smart controls. [Energy savings in the trials vary from 18% to 85%, with 20 out of 27 products achieving savings of 50% or more, and ten showing savings of 70% or more.]

Adaptive –Network Controls



Overlap of Lighting and Load



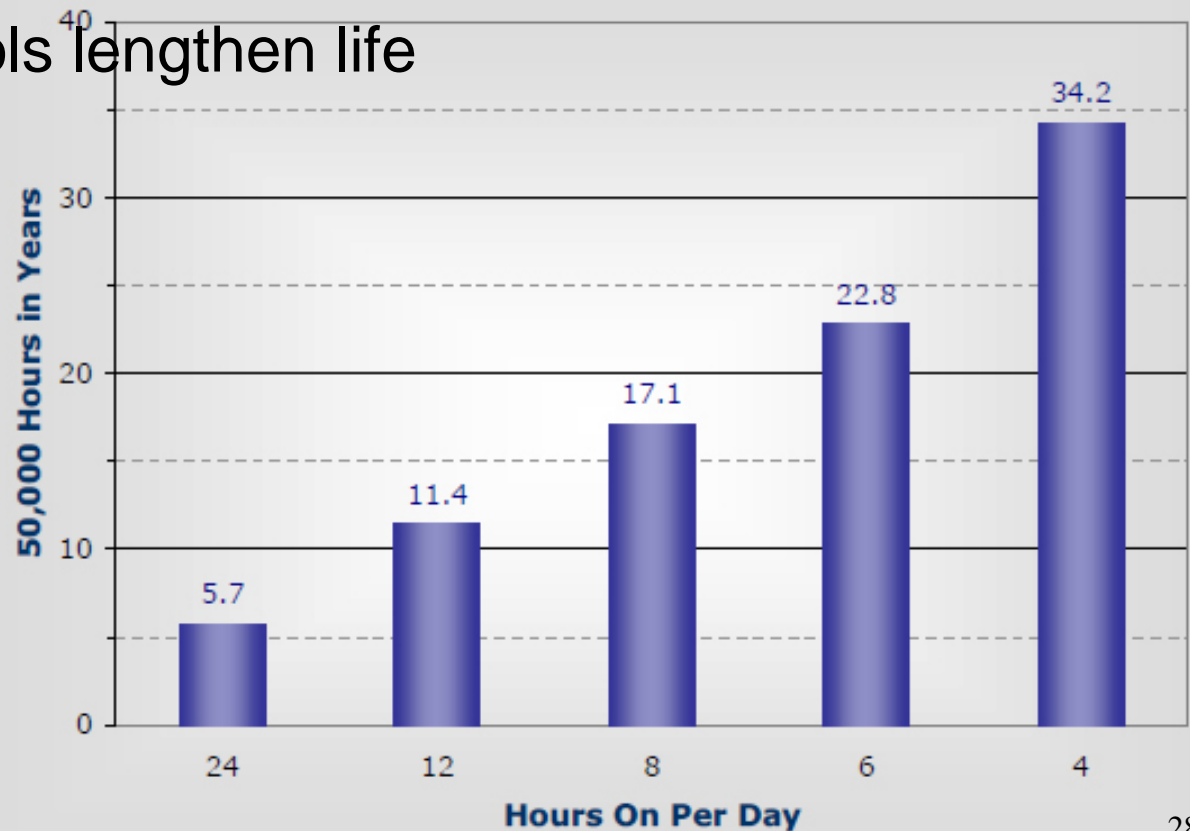
Typical Load Curve for Dual Peaking Utilities

Actual twilight and sunrise/sunset times for Portland, Oregon on Jan 8, 2013



Street Lighting -LED Lamp Life

- LED typically 50,000 hrs life
- Cleaning must be a part of maintenance
- Adaptive controls lengthen life



Los Angeles Crime Statistics

Pre & Post LED Street Lighting (2009-2012)

Crime Types	2009	2012	Percentage Change
Vehicle Theft	15,778	13,632	-13.60%
Burglary- Robbery-Theft	19,967	18,406	-7.82%
Vandalism	11,115	9,906	-10.90%
TOTAL	46,869	41,944	-10.50%

Incidents between hours of 7pm to 7am

2012 Next Generation LED Luminaire Competition



2012 Next Generation –Exterior Award Winner

Best in Class –Roadway Lighting

Light Output: **6289.4 lumens**

Input Power: **80.3 watts**

Efficacy: **78.3 lm/W**

Power Factor: **100%**

CCT: **3900K**, CRI: **72**



GE Lighting -**The Evolve™** LED Scalable Cobrahead, with its unique, advanced optical design using reflective technology, offers hundreds of photometric combinations.

Understanding- LED Street Lighting

Presenter-
Edward Bartholomew, LC, IALD, IES, LEED AP



BetaLED
Sentry Equipment—Oconomowoc, Wisconsin

Presenter-
Edward Bartholomew, LC, IES, LEED AP
Commercial Lighting | Program Manager

Poll Question #2

- What do you consider the most important benefit of LED streetlights?
 - Reduced costs
 - Decreased energy use
 - Improved safety
 - Darkened sky





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LED Streetlights

How to Move Forward

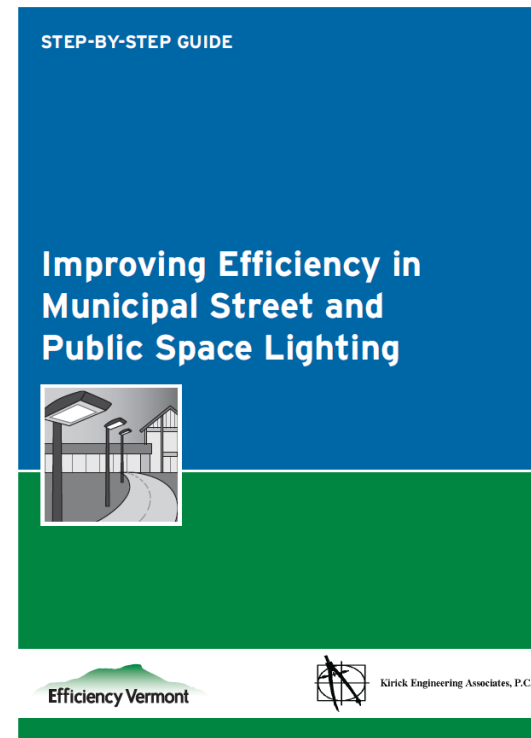
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Green Communities Division, DOER*

Efficiency Vermont: Improving Efficiency in Municipal Street and Public Space Lighting

1. Form a Team
2. Conduct a Needs Assessment
3. Prepare a Street Lighting Inventory
4. Determine Ownership of Light Fixtures
5. Identify and Eliminate Unnecessary Lighting Fixtures
6. Consider LED Replacement Lighting
7. Determine How New LED Fixtures Will Be Controlled
8. Prepare a Final Project Scope and Budget
9. Build Support
10. Secure Funding
11. Implement Project



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Streetlight Ownership

Can You Install LED Streetlights Today?

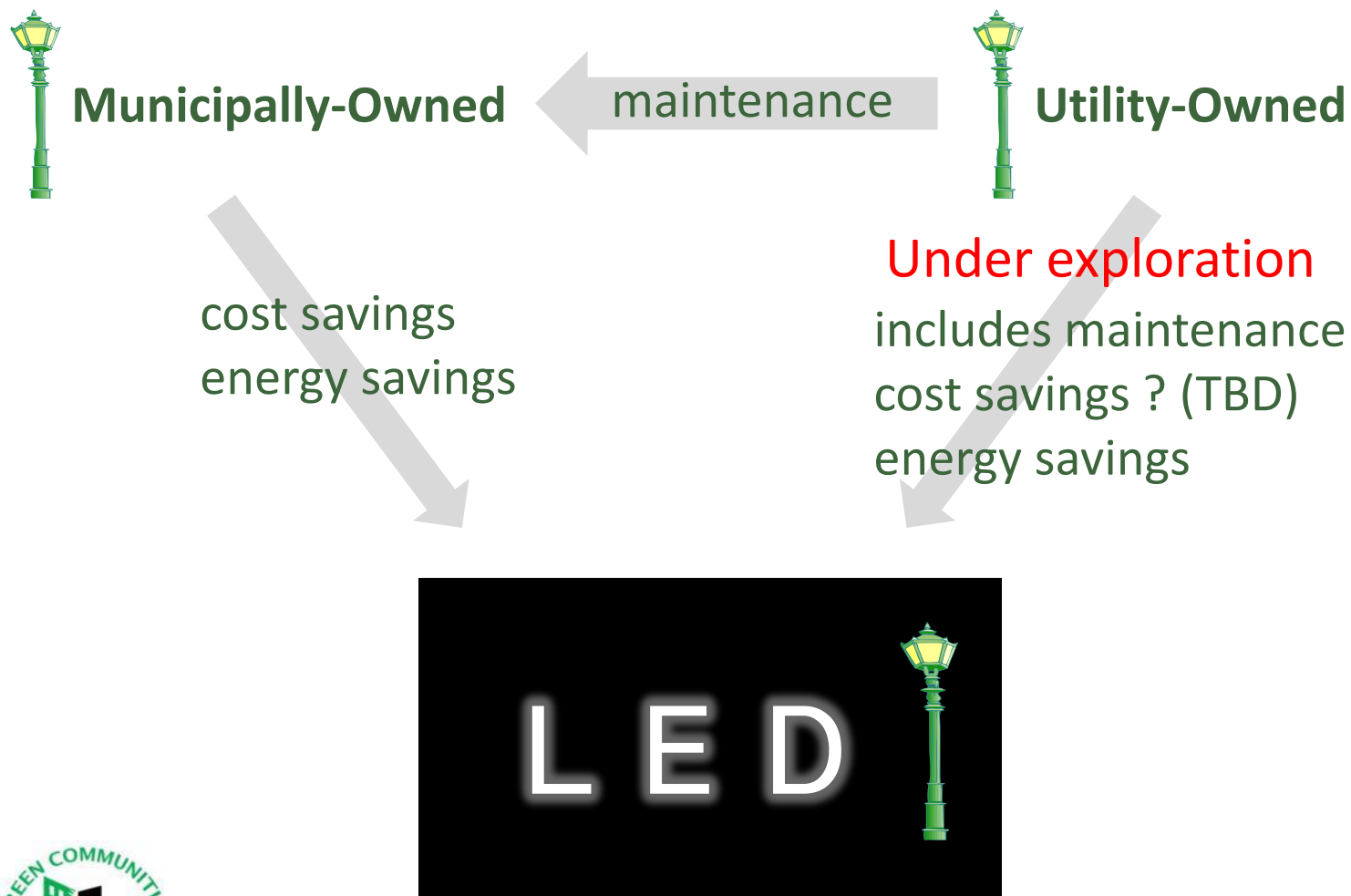
Ownership and Tariffs	Can You Install LED Streetlights Today?	
	Metered	Unmetered
Municipally-Owned	yes	yes
Utility-Owned	no	no



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Ownership Pathways to LED Streetlights



Municipal Tasks to LED Streetlights

Public Relations

- Streetlights are highly visible and can spark public debate

Lighting Standards

- Hire an expert to determine how much light is needed
- LEDs seem brighter due to their cooler color temperature
- Light level impacts cost of fixture

Procurement & Cost

- State Contract: Comm-Pass FAC76 Category 6
- MAPC joint procurement
- Include pre-install activities in scope

Financing

- 25A Energy Management Services available for performance contracting

Incentives

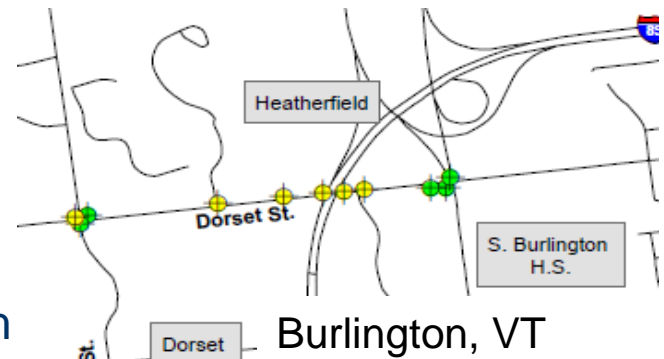
- Mass Save incentives available
- Must contact electric utility PRIOR to order/install
- Must be on Design Lighting Consortium qualified product list

Maintenance

- In-house labor for the installation?
- Combine installation and maintenance contracts or keep separate?
- Need any changes to existing maintenance contract?

Perform Streetlighting Design Study

- Obtain electric utility's list and map of streetlights
- Verify streetlight inventory with locations, types and wattage
- Determine if there are locations where streetlight wattage could be reduced (or eliminated)*
- Have a lighting expert assess proposed streetlight reduction areas to recommend lighting levels with LEDs
- Approve target list with local public safety agency and legal department
- Present list to municipal officials and public for input
- Conduct a trial of the new lighting levels
- Ready for LED lighting



* Requires safety analysis and public outreach

LED Applications

- Traffic lights
- Metered streetlights
- Decorative streetlights
- Parking lot/garage lights
- Exterior building lights
- Unmetered streetlights



MA Munis with LED Exterior Lighting

Green Communities Grants		Other Known LED Exterior Lighting Projects	
	Type		Type
Acton	Metered, parking lot & spot lighting	Cape Light Compact	Unmetered
Arlington	2 unmetered projects: GC plus MAPC group procurement	Boston	Unmetered plus metered decorative
Easthampton	Unmetered	Chelsea	Unmetered via MAPC group procurement
Holyoke	LED traffic signals (plus parking and streetlights using own funds)	Fitchburg	Metered, decorative
Lexington	Induction streetlights	Natick	Unmetered via MAPC group procurement
Melrose	Metered, decorative	UMass Amherst	Metered, parking lot
Salem	Metered, decorative	Woburn	Unmetered via MAPC group procurement

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General Streetlight Resources

- Efficiency Vermont's Step-by-Step Guide: Improving Efficiency in Municipal Street and Public Space Lighting

http://www.efficiencyvermont.com/docs/for_my_business/lighting_programs/EVT_MunicipalStreetLightingGuide_Rev040111.pdf

- DOE's Municipal Solid State Lighting Consortium

<http://www1.eere.energy.gov/buildings/ssl/consortium.html>

- The Clinton Climate Initiative's Street Lighting Retrofit Projects

http://www.clintonfoundation.org/files/CCI_whitepaper_lighting_2010.pdf

- DOE's Technical Assistance Program's webinars:

- Overcoming Common Pitfalls: Energy Efficient Lighting Projects, (October 10, 2010)
<http://www1.eere.energy.gov/wip/solutioncenter/webcasts/default.html>
- Exterior Solid State Lighting Solutions for Municipalities (April 19, 2011) <http://tinyurl.com/k2uke3v>



Helping Massachusetts Municipalities Create A Cleaner Energy Future



Streetlight Procurement Resources

- State Contract
 - www.comm-pass FAC76, Section 6
 - Dmitriy Nikolayev, Dimitriy.Nikolayev@state.ma.us
- MAPC Joint Procurement
 - Erin Brandt, EBrandt@mapc.org
 - <http://www.mapc.org/led-street-lighting>
- Energy Management Services for Performance Contracts
 - Eileen McHugh, Eileen.McHugh@state.ma.us
 - <http://www.mass.gov/eea/energy-utilities-clean-tech/green-communities/ems.html>



Compliance with Construction Law

Some purchases of lighting fixtures under this contract fall under the requirements of statutes governing building and public works construction (MGL Chapter 149, and Chapter 30 Section 39M respectively). The following table explains how those statutes apply to the contract, based on the ordering option and project type:

Project type	Order / Project Size Limit Under the Contract	Applicable Procurement Law for Projects Above Order / Project Limit
Fixtures for projects using municipal staff	No limit	N/A
Fixtures for multiple projects using hired labor (installation procured separately)	No limit	N/A
Fixtures for a single project using hired labor (installation procured separately)	\$10,000	MGL Chapter 30 Section 39M*
Fixtures and installation procured together	\$10,000	MGL Chapter 149, or Chapter 30 Section 39M*

- Eligible Entities are advised to consult the Inspector General's Office for guidance on the application of the construction statutes referenced above.



Compliance with Construction Law

- **Definition of “project.”** If an Eligible Entity intends to install fixtures in multiple locations, the following guidance will apply:
- If the work is going to be performed in phases and potentially by multiple installers (i.e., when installers are allowed to bid on portions of the work, even if one wins everything), Eligible Entities may consider each phase / portion of the total scope of work to be a separate project. The contract does not impose a limit on the purchase of fixtures for multiple projects, as long as the fixtures do not require to be installed by “manufacturer certified” contractors. Eligible Entities may order all the fixtures at once and stock them, or they may schedule separate deliveries for each project under the same purchase order.
- If the work in all the locations/spaces/buildings is going to be performed at the same time and is expected to be awarded to only one installer, it should be considered one project. The contract limits purchases of fixtures for such single projects with hired labor to \$10,000.



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Thank You

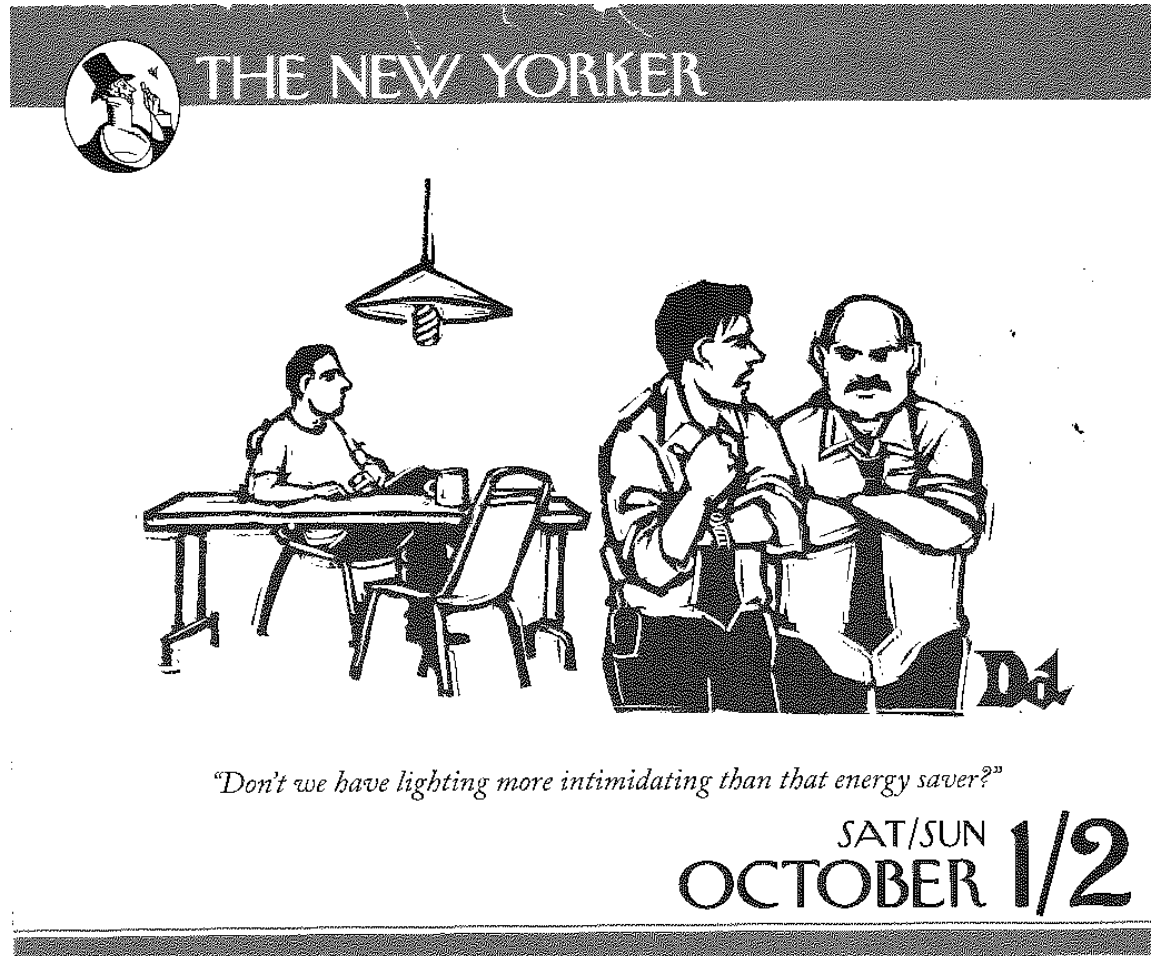
- Edward Bartholomew
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 - Edward.Bartholomew@nationalgrid.com
- Aimee Powelka
 - Municipal Efficiency Coordinator, Green Communities Division
 - Department of Energy Resources
 - Aimee.Powelka@state.ma.us
 - 617-626-7356
- Are You Willing to Share Your Streetlight Project?
 - Please write in your contact info to the webinar or email:
Aimee.Powelka@state.ma.us



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Time for Some Tough Questions



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